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Research Report

POSITIONAL ALCOHOL NYSTAGMUS IN

RELATION TO LABYRINTHINE FUNCTION*

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SUMMARY PAGE

THE PROBLEM

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The main objective was to evaluate the use of positional alcohol nystagmus as an indicator of otolith function.

FINDINGS

Individuals without functional labyrinths did not exhibit nystagmus comparable in quality or magnitude to results obtained from a group of normal subjects. Several individuals suspected of having residual otolith function exhibited weak responses reminiscent of PAN, but the "responses" may have been attributable to artifacts.

A relationship was found in normal subjects between nystagmus obtained by caloric stimulation and nystagmus obtained by positional alcohol testing.

The relationship between nystagmic output and arousal was found to be essentially the same for positional alcohol nystagmus as for nystagmus obtained by other procedures.

All labyrinthine-defective subjects tested for alcohol gaze nystagmus exhibited alcohol gaze nystagmus.

AUTHOR

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INTRODUCTION

The present experiments were initiated to test for the presence of positional alcohol nystagmus (PAN) in several categories of individuals differing in labyrinthine function, including persons who had given evidence of residual otolith function in otherwise nonfunctional labyrinths. This evidence was inferred in a previous experiment (12) from responses indicating bilateral loss of canal function and hearing, as shown by ice-water caloric tests and audiometric examination, but nearly normal oculogravic illusions. Other individuals with equivalent deficits indicated by the caloric and audiometric examinations exhibited abnormal oculogravic illusions. Hence this perceptual event, which is independent of canal function but which does involve otolith stimulation, could signify residual otolith function in those subjects with a normal response*. It was our good fortune that most of these same subjects were available for the present experiment.

The release mechanism of positional alcohol nystagmus has not been clearly established. Fernandez and coworkers (11) have demonstrated positional nystagmus in cats by lesions in the nodules. This nystagmus, however, is direction-fixed and vertical in nature. It appears that one functional nonauditory labyrinth is necessary for the elicitation of positional nystagmus as indicated by deKleyn and Versteegh (9) in rabbits and by Aschan and Bergstedt (3) in man, despite some evidence to the contrary by Nylen (19) and Skoog (20). Excellent reviews of this topic have been presented by Bergstedt (4) and Nylen (18).

The position of the head relative to gravity is of importance in positional nystagmus as the name implies. In some cases of positional nystagmus, the nystagmus direction is the same irrespective of whether the particular eliciting position is attained from an initial face-up position or from an initial face-down position (18). This, plus the evidence that elicitation of PAN requires at least one intact labyrinth (4) suggests that the otolith organs may be essential to the release and maintenance of PAN. Hence PAN may also be an indicator of otolith function.

Specifically the present experiments were initiated to compare PAN in three categories of people: 1) individuals who were suspected of having residual otolith function but otherwise nonfunctional labyrinths, 2) individuals with apparent complete loss of labyrinthine function, 3) apparently normal individuals. The normal subjects were also used in a further investigation into the relationship between labyrinthine function and PAN by comparing the nystagmus elicited by controlled caloric stimulation to the intensity of PAN. These experiments were carried out under three subject-activity conditions to allow for response variability attributable to this factor (7,8) and to ascertain whether the already established relationship between arousal and the more typically induced vestibular nystagmus would also be present in PAN.

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* although other "gravity receptors" are also stimulated and auxiliary cues are probably very effectively used by the deaf.

Positional Alcohol Tests

Body weights and alcohol dosages for the normal and for the L-D subjects are presented in Table I.

The sequence of head positions was as follows: 45 seconds with body and head in supine position (neck ventroflexed by pillow about 20 degrees), 90 seconds with head rotated to left, 45 seconds in initial position, 90 seconds with head rotated right, 45 seconds in initial position. The frontal plane of the skull in the initial position, and the sagittal plane of the skull in the other positions, was about 20 degrees out of the horizontal plane. This procedure was followed for each subject one hour after and again two hours after the consumption of alcohol (an equal mixture of 80 proof vodka and orange juice). Tests were conducted in a dark room with the subject's eyes open in some sequences and closed in others. Subjects were given instruction and practice to move their heads smoothly through the 90 degree angles in about three seconds.

To assess arousal effects on positional alcohol nystagmus, ten normal subjects were given a hand-grip task and a mental arithmetic task. An example of one test sequence follows: head left 30 seconds with no task, 30 seconds of mental arithmetic (adding two digit numbers), 30 seconds with no task; head center for 45 seconds; head right 30 seconds with no task, 30 seconds hand-grip (squeezing two pieces of gauze with a hard constant pressure, but without producing tonic spasm); 30 seconds with no task; head up 45 seconds. The remaining normal subjects performed the reverse sequence first, i.e., hand-grip during the left head position and mental arithmetic during the right head position.

Scoring

Eye movement records were scored for frequency of nystagmic beats and total degrees of slow phase eye displacement. Scoring of records obtained during caloric tests was restricted to the first thirty seconds of the mental arithmetic task, i.e., the thirty seconds beginning forty seconds after the end of the caloric stimulation. The number of nystagmic beats (frequency) and the total degrees of slow phase eye displacement were measured and the sums from the tests of the left and right ears were obtained, respectively, for these two measures for each subject.

Positional alcohol nystagmus records were scored similarly throughout each of the head-left and head-right positions. This gave thirty seconds of pre-task, thirty seconds of task, and thirty seconds of post-task.

RESULTS

L-D SUBJECTS

In the initial testing of the L-D subjects, none yielded positional alcohol nystagmus (PAN I or PAN II) comparable to that of the normal subjects. Consequently, when seven of these subjects were again available (one year later), dosages were increased as shown in Table I. In the second test, they were tested for PAN I only.

With the stronger dose, one L-D subject (HA) exhibited PAN which was comparable in quality (except for a blink artifact in the right-beating nystagmus), persistence, and intensity to the lower range of normal PAN I responses as shown in Figure 1.* This nystagmus was particularly in evidence one hour after the alcohol dose. Two hours after dose, only the right-beating nystagmus was present, but at this time the recording was free of the apparent blink artifact which distorted the right-beating nystagmus in the first hour. This subject was one of the six L-D subjects who readily perceived the oculogravic illusion.

Of the other six L-D subjects, two showed nystagmus during the heavier alcohol intoxication, but these responses were not within the range of responses obtained from the normals. Subject GU had a horizontal, right-beating, spontaneous nystagmus which was interrupted during the head-left position and was present in the starting position and in the head-right position. This spontaneous nystagmus was also present, perhaps to a lesser extent, in testing periods not involving alcohol intoxication, and in the previous testing with the lighter dose. Hence this response cannot be identified as positional alcohol nystagmus although head position, perhaps through residual otolith function or neck muscle proprioceptors or other causes, appears to modify its character. This subject also had indicated a near-normal oculogravic illusion. In the other L-D subject (PE) who gave some indication of nystagmus, an inconsistent response suggesting PAN I appeared about two hours after the dose; but a consistent nystagmus resembling PAN I appeared after 280 minutes. This response was of extremely low intensity and would not have been detected except for a very clear recording free of artifact in spite of exceptionally high response amplification. The magnitude and time of occurrence of this response were not within the normal range of PAN I responses. Unfortunately the response amplification was much lower during control testing, but positional nystagmus was not detected in this subject without alcohol intoxication. Once again, although the response when present cannot be classified as normal positional alcohol nystagmus, it seemed related to position and was possibly set off by residual otolith function or neck muscles or other causes. This subject (PE) had also indicated a near-normal oculogravic illusion.

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* With the lighter dose, this subject had yielded an inconsistent response but one which suggested the presence of PAN.

Two noteworthy artifacts were detected in the present experiment. Either of these artifacts is capable of producing records with the misleading appearance of positional alcohol nystagmus. One subject (ZA) misunderstood the experimenter's instructions and moved his eyes rather than his head upon the experimenter's signal. This produced an alcohol gaze nystagmus (AGN) with fast-phase right during the right head-turn signal, nystagmus-left during the left head-turn signal, and a recovery to a normal baseline free of nystagmus during the signal for initial head position. In other words, a response was produced which had all of the characteristics of a vigorous, clear PAN I. When the misunderstanding was corrected, this particular L-D subject did not exhibit PAN. He had indicated a near-normal oculogravic illusion.

Another L-D subject (PI) produced a record which resembled PAN, but in this case the form of the nystagmus did not appear to be quite normal, particularly after head position had been maintained for more than about ten seconds.* However, the "nystagmus" changed directions with the different head positions in a manner appropriate to PAN.

The pattern present in this recording was probably attributable to a position-dependent blink artifact influencing the horizontal recording channel. Subsequent tests have shown that, in the head-left position (sagittal plane near earth's horizontal with left ear down), a blink produces a pen deflection left as though the eyes had displaced left, followed by a return to center. The transition from fast to slow phase is not sharp as is common in good quality nystagmus; but when the head is turned to the opposite position, with right ear down, a blink produces a pen deflection right as though the eyes had deflected right (Figure 2). The direction of the artifact is the same in most subjects tested; hence, a record can be produced somewhat reminiscent of PAN I. Such an artifact can be minimized or eliminated by recording while the subject's eyes are closed, but in general the quality of nystagmus is better when the subject is in the dark with eyes open. Our recordings with Subject PI were made under both conditions, and he had no PAN with eyes closed. This subject had not indicated a normal oculogravic illusion.

As a result of the AGN obtained through misunderstood instructions to Subject ZA, the L-D subjects tested subsequently for PAN were also tested for AGN. All of these, seven in number, exhibited clear AGN. In each case the AGN was of good quality, with sharp transition from fast to slow phase.

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* Many deaf subjects yield nystagmus during the head movement, but this persists for only a short time and is not dependent upon alcohol intoxication. Hence, the persisting response should maintain the characteristics of vestibular nystagmus to be convincing evidence of PAN.

In summary, of the six L-D subjects who had indicated near-normal oculogravic illusions in a previous experiment, three exhibited responses during alcohol intoxication which bore some resemblance to PAN I but only one gave a response which was reasonably equivalent to the poorest response obtained from a normal subject. Positional alcohol nystagmus was not detected in the other L-D subjects, including three who had exhibited near-normal oculogravic illusions and five who had not.

NORMAL SUBJECTS

Rank-orders of the normal subjects in the caloric test and the PAN test were compared both for frequency of nystagmic beats and total slow phase eye displacement during nystagmus. These latter scores were obtained from the first thirty seconds of recording after a head movement. Since each subject made four head movements, his score was the sum of frequency of nystagmic beats for the four head movements. Table II presents rank-order correlations among these measures and, in addition, rank-order between caloric threshold values and PAN. The coefficient (.84) between slow phase displacement during caloric stimulation and slow phase displacement during PAN is significant at 5 per cent level of confidence. The correlation coefficient between PAN frequency and PAN slow phase displacement is significant at the 1 per cent level of confidence. Two more coefficients approach significance at the 5 per cent level of confidence: the correlation between caloric slow phase displacement and caloric frequency is .60 (N=10; 5 per cent level requires .65); the correlation between caloric slow phase output and PAN frequency is .72 (N=8: 5 per cent level requires .74). None of the other correlation coefficients approaches significance.*

Figure 3 presents a comparison of total slow phase eye displacement in the PAN of normal subjects when the different tasks were carried out. Mental arithmetic clearly raises the slow phase output before, during, and after the task. The anticipation and persisting effects of mental arithmetic tasks have been previously noted (6). Handgrip did not produce an increase in slow phase output during the task. When the mental arithmetic and handgrip tasks were compared on basis of nystagmus output, mean differences reached statistical significance during the task interval and also after the task interval.

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* Correlation coefficients with small numbers of subjects as in the present experiments should be regarded with caution until further evidence is available.

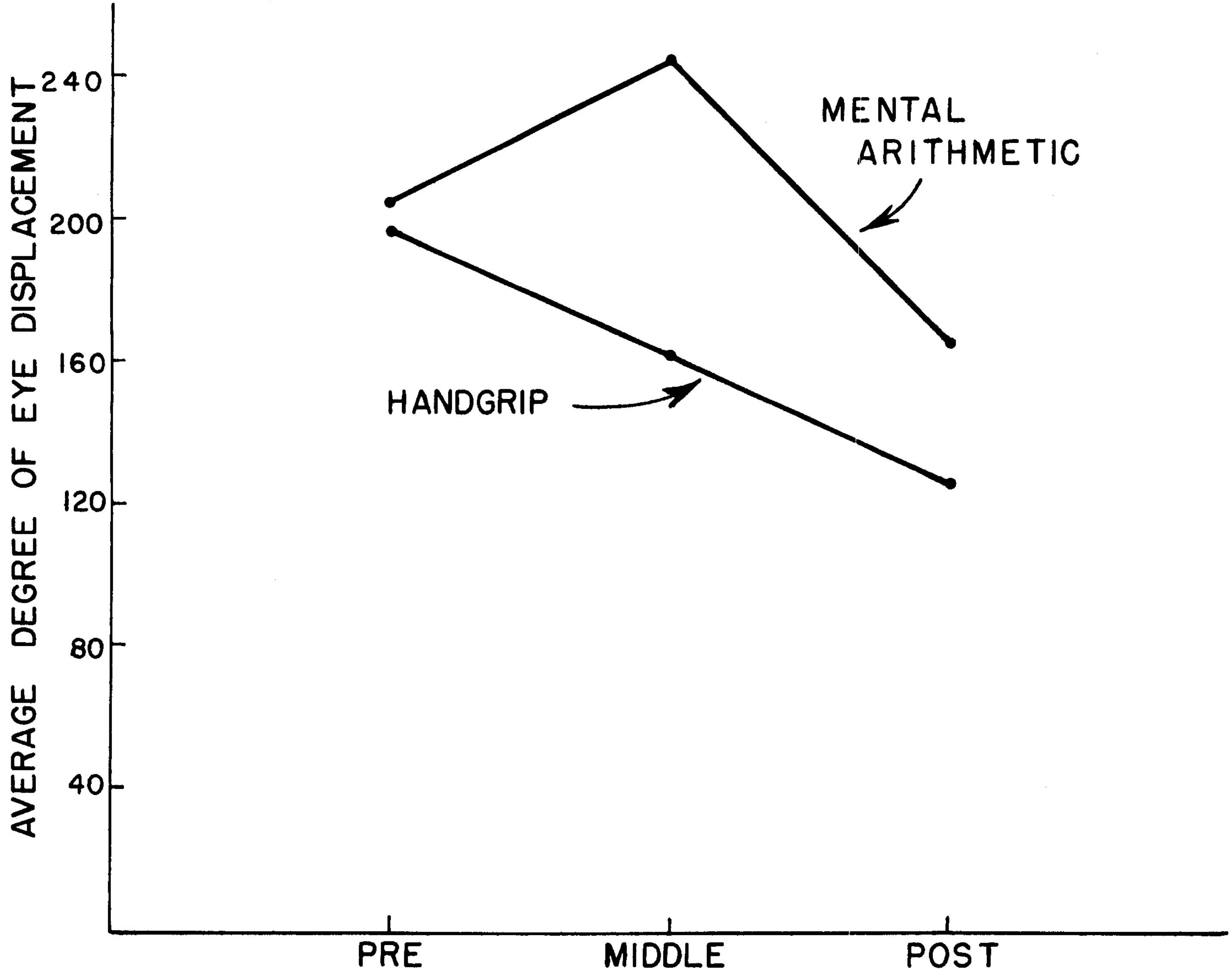

Figure 3

Comparison of Mean Total Eye Displacement (in Degrees) for Normal Subjects during Two Assigned Tasks

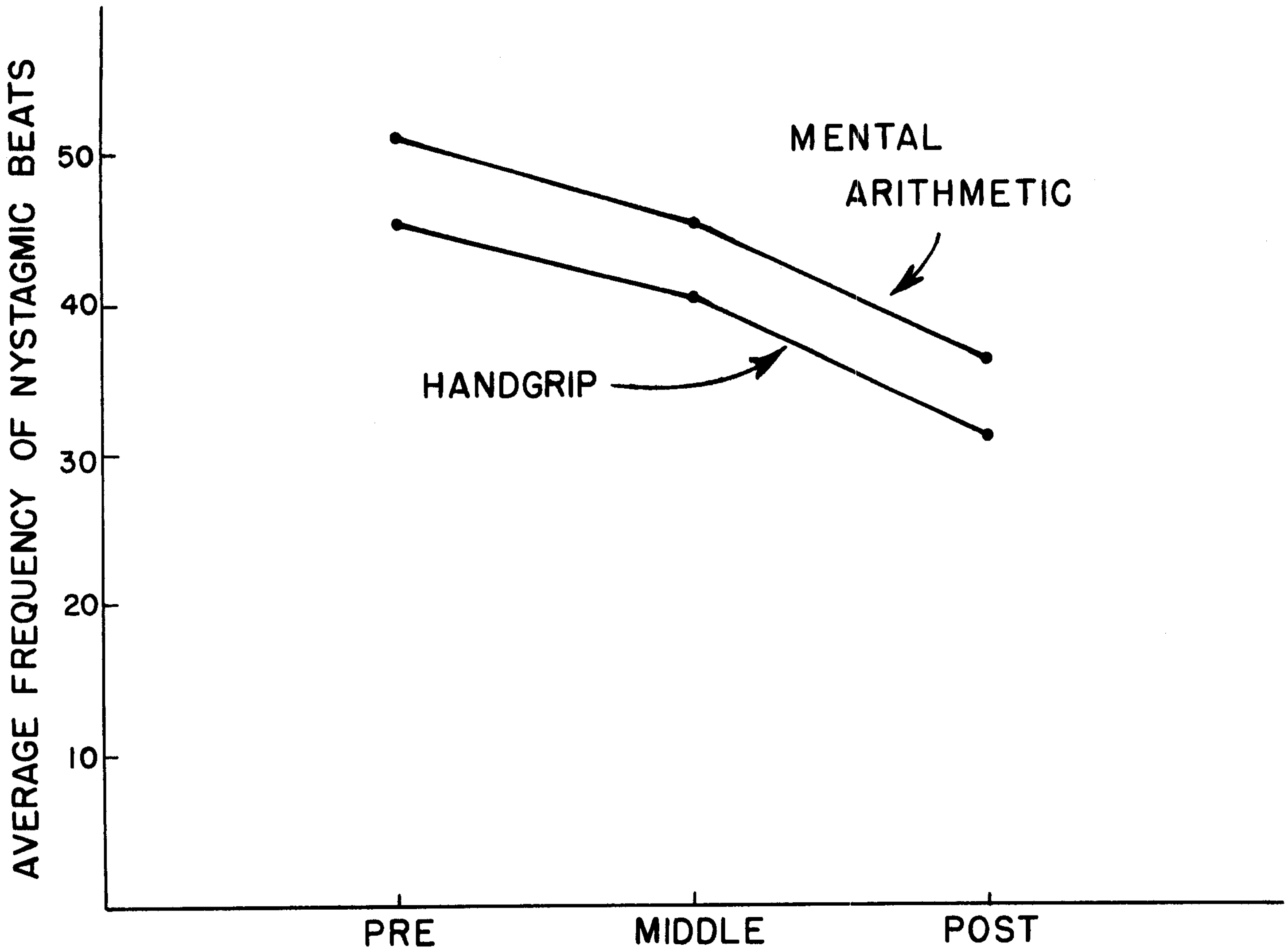

Figure 4

Comparison of the Average Frequency of Nystagmic Beats for the Normal Subjects during the Two Assigned Tasks

Figure 5

Comparison of Nystagmus Obtained When Left and Right Head Positions Were Attained from Nose-up and Nose-down Starting Positions

4. The recorded frequency of nystagmic beats produced by the more intense caloric stimulus did not correlate significantly with either frequency or slow-phase velocity of PAN. This is probably attributable to the use of mental arithmetic during the caloric test. In some subjects, mental arithmetic increases the amplitude and slow-phase velocity of nystagmus but reduces the frequency. Because all subjects did not receive all tests, it was not feasible to compare mental arithmetic PAN with the caloric results.

5. Whatever the mechanism of positional alcohol nystagmus, it is clear that arousal by mental arithmetic has a very similar influence on PAN and vestibular nystagmus produced by conventional stimuli. Mental arithmetic increased the average slow-phase velocity of PAN. On the other hand, muscle tension produced by a handgrip task was not clearly effective in modifying PAN, although it may produce an increase in frequency in some subjects.

6. A clear AGN response was obtained in all deaf subjects who were tested for this response.

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